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(12) (19) (CA) **Demande-Application**

(21) (A1) **2,220,653**
(22) 1997/11/06
(43) 1998/07/31

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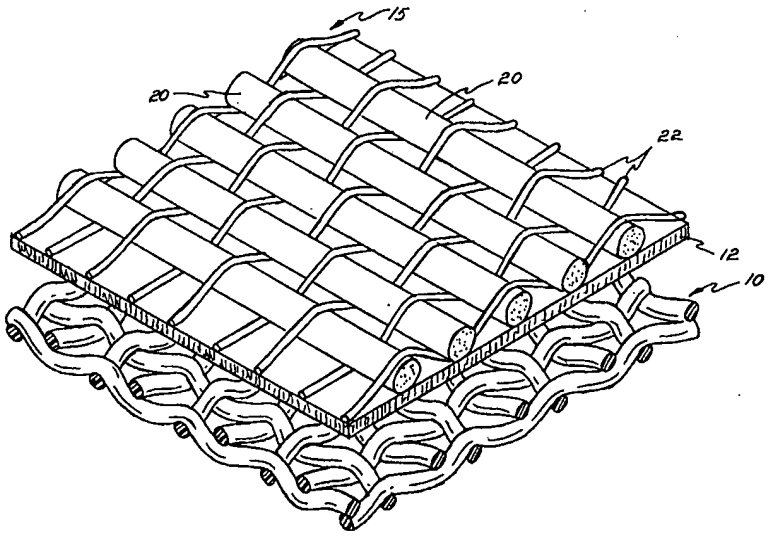
(51) Int.Cl.^{6} D21F 7/08
(30) 1997/01/31 (60/037,009) US

(54) **FEUTRE D'IMPRESSION DE SECTION DES PRESSES POUR PATE A PAPIER, METHODE D'IMPRESSION ET DE SECHAGE DE PATE A PAPIER, ET FEUILLE DE PATE PRESENTANT DES RAINURES EN SENS MACHINE DEMONTRANT DES CARACTERISTIQUES DE SECHAGE ET DE RESISTANCE AMELIOREES**

(54) **IMPRINTING PRESS SECTION FELT FOR PAPER PULP, METHOD OF IMPRINTING AND DRYING PAPER PULP, AND PULP SHEET HAVING MACHINE DIRECTION GROOVES AND RIDGES FORMED THEREIN WITH ENHANCED DRYING AND STRENGTH CHARACTERISTICS**



(57) Feutre humide pour la section des presses d'une machine à pâte à papier. Il est constitué d'un réseau de fils de marquage très épais s'étendant en sens machine sur la face du feutre, afin de former des rainures dans une ou plusieurs des surfaces de la feuille de pâte avant son acheminement à un séchoir, afin d'accélérer la vitesse de séchage et d'augmenter la résistance humide de la feuille de pâte. On fournit une description d'un procédé selon lequel des feuilles de pâte sont formées au moyen d'une surface rainurée par pression dans la section des presses avec un feutre présentant des côtes en sens machine, afin d'obtenir les impressions voulues. On décrit également le produit obtenu par ce procédé.

(57) A wet felt for the press section of a paper pulp producing machine is formed with an array of machine direction extending heavy marking yarns on the face surface of the felt for the purpose of forming ridges and valleys in one or more of the surfaces of the sheet of pulp material before the sheet is delivered to an air dryer, for enhancing the drying rate and increasing the wet strength of the pulp sheet. A process is disclosed by which pulp sheets are formed with a grooved surface by pressing in the press section with a felt having machine direction cords formed in the felt to make such impressions, and the product so made in the process.

IMPRINTING PRESS SECTION FELT FOR PAPER PULP, METHOD OF IMPRINTING AND DRYING PAPER PULP, AND PULP SHEET HAVING MACHINE DIRECTION GROOVES AND RIDGES FORMED THEREIN WITH ENHANCED DRYING AND STRENGTH CHARACTERISTICS

RELATED APPLICATION

This application claims the benefit of prior U.S. provisional application Serial No. 60/037,009, filed on January 31, 1997.

BACKGROUND OF THE INVENTION

This invention relates to press section felts and more particularly to a specialized felt, the process of using the same and the process and product which results from its use in the form of an improved paper pulp sheet. The felt is particularly intended for use in the press section of a paper pulp producing machine in which the press section delivers a web in the form of a sheet of pulp to an air pressure type dryer.

Paper pulp mills commonly use fourdrinier machines for forming mechanical or chemical wood pulp in the form of a relatively heavyweight web on a wire, which web is then run through a press section in which press section felts remove a substantial portion of the water content. The wet but dewatered web from the press section is delivered to an air dryer in which the web is maintained in an airborne condition as it passes through the dryer stages. Commonly, such dryers are known in the paper industry as Flakt dryers.

The dryer delivers the web as a flat sheet which is then cut into convenient sections or slabs and stacked, as distinguished from being wound on a roll. These stacks of pulp sheets are later used in the manufacture of paper and paper products as a source of wood pulp cellulose which may then be repulped in a hydrapulper and optionally mixed with reclaimed fibers, as well known in the art.

The drying apparatus that maintains the pulp web in an airborne condition and therefore in generally non-contacting relation with impervious objects differs substantially from conventional paper web dryers that use a series of heated

dryer rolls also known as can dryers. In the airborne type dryer, referred herein by its tradename the Flakt dryer, the web from the press section is contacted only by heated air and is dried simultaneously from both sides. Such dryers are disclosed in U.S. patent numbers 3,321,165 and 4,212,113 incorporated herein by reference. In such dryers, upper and low blow boxes are arranged in facing relation and support such web along a path of travel in closely spaced but non-contacting relation with such boxes. A characteristic of the Flakt dryer is that it does not rely on heated contacting surfaces nor does it use dryer felts which maintain and support the web. Rather, the web is supported, during drying passes, by the air itself.

Conventionally, the web or sheet of pulp delivered from the press section to the dryer is a sheet which has smooth top and bottom surfaces, since the final press is either between the face surface of two felts supported in a nip between a pair of rollers, or against the face surface of one felt (usually carried on a grooved suction roller) and the rubber face surface of an opposing roll defining a pressure nip. In either case, commonly this press section at the nip is run at 1,000 pli (pounds per linear inch) or higher. The resulting web entering the air dryer therefore has surfaces which normally are flat and smooth corresponding to the support surfaces in the final press section stage. When a break occurs within the dryer, which is bound to happen from time to time, the dryer must be opened up and the broke removed by hand. Since the broke is relatively heavy and has not dried sufficiently to have adequate strength, it often breaks into small pieces as it is removed, resulting in tedious and time consuming removal and clean up.

SUMMARY OF THE INVENTION

One aspect of the invention consists of a specially modified press section felt in which special machine direction or longitudinally extending yarns are bound to the open or face surface of the felt by needling a lightweight non-woven batting into the felt and into and through an array of special machine direction yarns. These yarns are substantially larger than any of the yarns in the base material and therefore are formed of relatively heavyweight, and preferably, a twist material. The yarns are woven as a separate fabric by using lightweight fill yarns primarily for the

purpose of providing some structure in orientation to the machine direction yarns, to permit handling and laying of the fabric for needling.

The batting which is used for the purpose of providing adherence to and protection for these face or surface oriented machine direction special yarns must be sufficiently heavy in weight so as to provide firm adherence to the base batting and base fabric and yet must be sufficiently light so that the special machine direction yarns will imprint into the newly formed web, in the press section, thereby to form an imprinted pattern on one or both sides of the web. The imprinted pattern, as described below in further detail, provides a pulp web with machine direction extending alternating compression grooves or valleys and ridges, at least on one surface, but in a press section using two opposed felts, on both surfaces. The increased surface area which results substantially enhances the rate of drying of the pulp web in the Flakt dryer.

This increased rate of drying is due not only to the increased surface area but is also believed to be due to the airflow interrupting and diverting effect of the valleys and the ridges. Since the air from the air jets necessarily impinges the surface and flows laterally, any decrease in the boundary layer condition or any disruption which creates greater turbulence at the surface, will necessarily and inherently increase the rate of moisture transfer from the web into the air. Therefore, a significant portion of the increased rate of drying is believed to be due to the turbulence inducing effect which the alternating ridges and compression grooves have on the airflow which results in a reduction of the boundary layer and a corresponding increase in the rate of moisture removal.

A further and unexpected result of the formation of a sheet having machine direction ridges and depressions (compression grooves), as described, is the fact that this sheet has been observed to have substantially increased early strength. In the case of a web break within the dryer, it has been observed that the broke can be removed by handling and pulling, using conventional techniques, in much larger pieces than before, thus substantially and significantly reducing the clean up time and the down time by reason of the break. It is believed that this substantial strength increase is due not only to the compression zones at the grooves, that are believed to

add to the tensile strength to the sheet, but also due to the greater extent of dryness within the web itself which directly and positively impacts upon the tensile strength.

The web which has been treated by and imprinted by the felt of this invention in the high pressure nip of a press also has, transversely, regions of relatively high compaction or density of fibers at the indentation portion of the ribs separated by regions of somewhat lower density. While this variation in density would be undesirable in most finished products, it does not adversely affect the usefulness of the sheets thus made since they are intended to be repulped when the pulp product is eventually utilized. However, it is believed that these high density machine direction portions also contribute significantly to the tensile strength of the web in the partially dried condition and contribute to its ease of removal in larger sheet sections in the process of cleaning up a web brake.

Therefore, another aspect of the invention is the provision of an improved web or sheet in formation and in drying, within the dryer, which has an improved and accelerated characteristic of drying and which has greater strength, in the drier, compared to a plain web of the same weight. A further advantage of this sheet is that it has a high slide angle when stacked with other sheets and therefore is easier to collate and stack into large bundles for subsequent use.

Another important aspect of the invention is the provision of a press section felt for use in the dewatering of newly formed webs of pulp at pulp mills and the like which felt has an imprinting surface formed of machine direction extending yarns that have been integrally bonded to the felt by needling and which are covered by a thin scrim or layer of non-woven batting. The batting is interlocked with the underlying structure of the felt including the felt batting and backing, preferably by needling from both sides. The felt provides an imprinting or marking surface for forming machine direction extending ridges and valleys on the web for enhancing the drying characteristics of the web, and the strength of the web in the dryer.

A further important and unexpected advantage of the invention relating to the felt is that field tests on such felt has indicated that it has superior water removal characteristics and durability. The special machine direction yarns form intermediate drainage channels which have been found to remain open and

relatively immune from compaction over extended use. Felts have been removed after running approximately 60 and 80 days respectively and in other cases over 140 days which should at that time show substantial compaction and filling but rather show substantial openness and have maintained high drainage with minimal wear characteristics on the surface, thereby leading to a reasonable expectation of longer on-machine performance as compared to conventional smooth surface press section felts. This increase in felt life and observed openness was not expected and it is believed to be due to the ability of the felt to maintain a high degree of openness between the machine direction imprinting yarns by reason of the concentration of the nip loading in the exact region of the individual special marking yarns and therefore a reduction of the loading in the spaces between the yarns.

In the manufacture of the improved press section felt of this invention, a conventional duplex weave base fabric will have a face batting and a back batting needled into the woven construction in conventional manner. One or more face battings may be applied. The base fabric may be woven endless or it may be provided with a pin seam. Such a duplex weave with a pin seam is shown in U.S. patent 4,938,269, for example.

While the fabric is in the needle loom, a second fabric is applied and positioned over the face surface. This fabric includes heavy and relatively widely spaced yarns which will be machine direction yarns in the finished felt and light fill yarns in the cross machine direction in the finished yarn, with the heavy machine direction yarns having a ratio to the base fabric warp yarns of 1 to 2 or higher, and typically may be spaced apart with a density of 8 to 10 to an inch or less. The weight of the heavy yarns, which will lie in the machine direction in the finished felt, may be around 1,100 grains per 100 yards. This second fabric is then needled into the base fabric using a lightweight non-woven batting in which the added batting is of a relatively low weight such as a 3/4 oz./sq. ft. batting, which is then needled in place through the face. Additional batting, if desired, may be needled through the back by turning the felt over in the needle loom. The felt will be finished in the conventional manner with the auxiliary heavy yarns finished in close relation to the ultimate face of the fabric so that, in the press section, these yarns will make a physical impression

into the pulp sheet or web, while the tension in the felt will be carried by the conventional woven base structure. The completed fabric may be about 4 to 6 oz./sq. ft. in weight, but the most important aspect of the felt is that the warp yarns in the added fabric are sufficiently close to the surface of the batting as to make a substantial impression along the length of the web on the face surface. A twisted yarn is preferred for these machine direction marking yarns in order to permit needle penetration through the yarn so that the body of the yarn may be adequately interlocked with the face batting to assure the integrity of the felt.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional view through the improved press section felt of this invention;

Fig. 2 is a perspective partially diagrammatic and partially broken away view showing the arrangement of the layers of woven material making up the felt of this invention;

Fig. 3 is a diagrammatic cross-sectional view of the disassociated elements of a felt looking at the machine-direction end with the cross machine direction represented by the arrow, showing the base fabric and the supplemental fabric, and diagrammatically illustrating the non-woven battings in a condition prior to needling, at their respective positions;

Fig. 4 is a representation of a high pressure carbon impression made at the face of a specimen of the felt made in accordance with this invention; and

Fig. 5 represents one surface of a pulp sheet which has been run through a press section using felts made in accordance with this invention, showing the impressed surface configuration including the longitudinal zones of relatively high compression separated by zones of lower compression;

Fig. 6 is an enlarged sectional view through the sheet of Fig. 5 looking generally along the line 6--6 of Fig. 5; and

Fig. 7 diagrammatically illustrates the principal components of a sheet forming pulp mill including a fourdrinier machine, a press section, a sheet dryer and stacker, to which the present invention is applied.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to Figs. 1-3 , Fig. 1 is a sectional view through a press section felt made according to this invention while Fig. 2 diagrammatically represents certain layers of material which go into the felt but does not show the unwoven material as being needled in place and does not show the top and bottom batting. Fig. 3 shows the relative position of the principal components of the felt of this invention. The felt has a conventional woven base fabric 10 which may be a duplex woven base, as well known in the art. A simplified illustration of the base fabric 10 is shown in Fig. 1 for the purpose of illustrating the manner of making the press section felt of this invention.

Next, the base fabric 10 has needled into it from the face surface as well from the back surface, battings 12 and 13 of non-woven material. The batting 13 is applied to the roll side and the batting 12 is applied to the open or face side of the base fabric 10. A portion of the batting 12 will remain above the woven base fabric 10 and will tend to isolate the woven base from the special overlying base fabric which is to be applied by needling.

This overlying fabric is illustrated generally at 15 in Figs. 1 and 2 as including heavy machine direction extending spaced apart yarns 20, held together by a relatively lightweight cross machine yarn 22. This sheet side fabric 15 is then applied at the face side of the felt, while still in the needle loom. Of course, the felt may be woven endless or it may be woven as a pin seam felt.

The fabric 15 has heavy machine direction yarns 20 which typically have a spacing of about twice that of the machine direction yarns 10a in the base as shown in Fig. 3. A typical density which has proved to be effective is 8 to the inch.

Then, on top of the fabric 20 is placed a further batting layer 23. The batting layer 23 is then needled into the composite felt from both the top and from the back side. For example, in a 5.38 oz./sq. ft. felt, the supplemental batting 23 which is added for the purpose of fixing and attaching the yarns of the fabric 15 was a 3/4 oz./sq. ft. batting, while the face batting 12 which had previously been applied was a 1 1/4 oz./sq. ft. batting and the base or roll side batting was about 3/4 oz./sq. ft.

After the application of the fabric 15 in position over the face of the needled batting 12, the composite structure is again needled from both the face side and from the back side. Fig. 1 illustrates that a minimum of the unwoven or batting fibers will extend above the face side or upper side of the felt as seen at 25, sufficient to interlock in place and hold the heavy yarns 20 in a locked condition with respect to the base fabric.

The heavy yarns 20 become the marking yarns. Typically, these yarns comprise a twisted plied multi-filament that provide the necessary hardness to carry the loading in the nip, and to provide the necessary compaction to the web of pulp material. In a preferred example, the yarns 20 consist of three bundle groups each of which consists of two twisted together bundles of fibers each individual bundle having a total denier of about 840, thereby providing a denier of 6 x 840, or a weight of about 1,100 grains per 100 yards. It is within the scope of this invention to use a heavier or a lighter weight yarn, or to use a spun yarn, a plied multi-filament yarn, as disclosed, or even a monofilament yarn, as the yarns 20, as long as they can be adequately attached to the face side of the fabric.

The fill yarn 22 may be woven as a plain weave and its purpose is to provide integrity to the fabric 15 and to hold the heavy machine direction marking yarns 20 in place prior to and during the beginning of the needling operation. Thus, a lightweight monofilament may be used, such as an 11 mil monofilament having a weight of 100 grains per 100 yards. After needling, the felt may be conventionally finished.

Fig. 4 represents the image made by a carbon impression taken at the face or sheet surface of a felt in accordance with this invention, loaded at 1,000 psi. The ribbed pattern which is left by the yarns 20 is evident, as represented by the lines 20a in Fig. 4.

Fig. 5 is a view of one surface of a dryed sheet 40 of paper pulp which has been pressed, as a web, in a press section at 1,100 pli at 600 ft./min. between opposed pairs of pressed section felts in accordance with this invention. The dry basics weight of this sheet was 600 lbs./1,000 sq. ft. The opposite side of the sheet is similarly formed as a series of ridges and depressions as shown in Fig. 6,

corresponding to those imparted to the sheet on the surface as illustrated in Fig. 5 without regard to alignment between the opposed arrays of imprinting yarns. Thus, the sheet 40, as illustrated, has one or both of its surfaces heavily indented and compressed longitudinally or in the machine direction to form grooves, valleys or compressed zones 42, corresponding to the positions of the yarns 20 in the press section, separated by wider regions or ridges 44 of cellulose material which has been compressed to a lesser degree. The mean caliper of the sheet was about 1/16 inch. The valleys or zones 42 were compressed by about 16% to 25% of the total caliper thickness of the sheet, after drying.

This sheet, in a partially dryed state, has been found to have high tensile strength, particularly when pulled in a direction parallel to the longitudinal direction, i.e. parallel to the ridges 44 and this strength, over that of a conventionally pressed shape, is believed to be due to the zones 42 of high compaction which, even in a partially dryed condition enhance the tensile strength of the partially dryed sheet. For this reason, it has been surprisingly found that broke within the drier can be cleaned out at a fraction of the time required to clean out broke formed by a conventionally pressed web of the same weight, thus providing substantial savings in down time.

A further advantage of the ribbed pattern is its ability to increase the drying rate, even when the ribbed pattern is formed on one side only. It is believed that this increased rate of drying is due not only to the increased surface area which has been exposed by the impressed pattern, but also due to the ridges 44 forming turbulence inducing projections which promote mixing within the boundary layer region and thus promote a decrease in the thickness of the boundary layer, during air drying.

Field tests have indicated that the press section felt according to this invention has a capability of running longer than the conventional felt, as measured by the degree of compaction and wear which occurs in use. Generally, press section felts must be replaced when the compaction reaches the point where the felt no longer adequately drains as measured by an increase in web moisture at the dryer end. To compensate, the speed of the line must be reduced. Substantially less

compaction has been seen in felts made in accordance with this invention that have been removed for routine replacement. It is believed that this may be the result of a selective distribution of the nip loading, as illustrated by the carbon print in Fig. 4, to the regions of the marking yarns 20, thereby forming intermediate regions of substantially lower compression. Lower compression over a substantial area of the felt translates into a correspondingly longer service life for the felt.

Referring to Fig. 7, which only diagrammatically illustrates some of the components of a pulp mill, a sheet forming device may be a fourdrinier wire 80 in which a headbox applies a slurry or suspension of the pulp on the wire 80 for drainage.

The off running end of the fourdrinier applies the formed and partially dried sheet 82 to one of a series of typical press sections, in which water is extracted by running the sheet 82 between pairs of pressure rolls such as the rolls 84 and 85. One or more of these rolls is covered by a felt made according to this invention which carries a substantial quantity of the wetness of the sheet 82 away from the pressure nip defined between the pairs of rolls. Press sections may include only a single felt over a suction or grooved roll or may include a pair of felts, and typically two or three or more separate press sections are used. Typically, the felt of this invention will be used on the last of the press sections in order that the imprints made by the felts on the sheet 82 go into the air dryer 100 although the felts of this invention may be advantageously used for the felts in any one of the press sections. As illustrated in Fig. 7, an upper felt 86 goes over the upper press roll and a lower felt 88 forms a nip with the felt 86 at a lower press roll. Typically, pressures in the press section may run at from 500 to 1,400 PLI pressure loading typically at speeds in the range of 200 to 600 feet per minute.

The sheet 82 leaving the air dryer or driers is typically cut and stacked as shown at 110 for binding and shipment to paper plants or newsprint plants. The sheets in the stack 110, where an upper and lower felts are used in the final press section according to this invention, will be formed with indented and compressed longitudinally extending compression zones 42 and separated by wider regions 44 of cellulose material which has been compressed to a lesser degree, as described above

in connection with Figs. 5 and 6. The surfaces thus configured tend to hold the sheets in a stack better than the conventional smooth sheets in that the grooved surfaces provide greater friction and a higher slip angle. Tests have shown that overall production can be increased up to 5% by reason of the increase in drying rate of the sheets configured as shown in Figs. 5 and 6 as compared to conventionally formed smooth sheets of the same weight.

While the forms of apparatus, process and product herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, process and product, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

CLAIMS:

1. A wet felt for the press section of a paper pulp producing machine comprising a woven base fabric having machine direction warp yarns and cross machine fill yarns and having an inner batting layer defining a roll side and having an outer batting layer defining a face side, a second fabric on said face side, said second fabric having a plurality of machine direction yarns of a caliper which exceeds the caliper of said base layer warp yarns and having a cross machine spacing which exceeds the cross machine spacing of said base layer warp yarns, said second fabric having a cross machine yarn woven with said machine direction yarns for supporting said machine direction yarns in a desired relationship to each other on said face side, and a lightweight non-woven batting needled into said face side through said second fabric, wherein said machine direction yarns of said second fabric, form in a pulp sheet a transverse series of substantially parallel ridges and depressions.

2. The felt of claim 1 in which said machine direction yarns of said second fabric have a weight of about 1,100 grains per hundred yards and have a cross machine spacing of about 8 to an inch.

3. The felt of claim 2 in which said lightweight non-woven batting has a weight of about 3/4 oz. per square foot.

4. The felt of claim 1 in which said machine direction yarns of said second fabric comprise three bundle groups each of which consist of two twisted together bundles of fiber, in which each bundle has a denier of about 840.

5. A press section felt particularly adapted for use in the press section of a pulp forming papermaking machine in which sheets of pulp are dried in an air dryer, cut, and bailed for future use, said felt having a machine direction extending in the long direction of the felt and a cross machine direction extending in the width of said felt, comprising a base fabric having a roll face on one side and an open face on the other side, a plurality of yarns formed on said open face a plurality of individual machine direction yarns mounted on said open face and extending in a generally parallel array of yarns in said machine direction, said yarns having a size so as to cause corresponding parallel valley to be formed by the yarns in a pulp sheet pressing through in the press section of such a machine of relatively high compression separated by raised ridges of such sheets having a lower compression.

6. A long life felt for the press section of a paper pulp forming machine having a high resistance to compaction comprising a woven base, a first batting needled into said woven base forming a roll surface on one side thereof, a second batting needled into said woven base forming a face surface on the other side thereof, a second fabric mounted on said face surface, said second fabric having a plurality of machine direction extending yarns of a denier which substantially exceeds the denier of the warp yarns in said woven base and which have a cross machine direction spacing which exceeds the corresponding spacing of the warp yarns in said base fabric and having a relatively light fill fabric for retaining the yarns in place, a relatively lightweight second face batting needled into said second fabric and said base fabric, whereby said machine direction yarns of said second fabric define therebetween intermediate zones of lower compression separated by zones of higher compression, whereby said lower compression zones are resistant to filling over a substantial period of use of said felt in such press section.

7. The process of forming a pulp sheet specifically capable of improved drying in a air-type dryer comprising the steps of forming such sheet on a forming wire, delivering said sheet to a press section having pressing felts, and pressing at least one surface of said sheet by a felt having, on the face surface thereof, a plurality of spaced apart machine direction extending cords to impress on at least one surface of said sheet a series of grooves corresponding to the position of said cords... ridges corresponding to the spaces between said cords, and delivering said sheet to said air dryer.

8. The process according to claim 7 in which said grooves are formed in both sides of the sheet.

9. A sheet of papermakers' pulp made according to the process of claim 7 having an upper and lower surface, in which said at least one of said surface is formed with a plurality of generally parallel extending ridges in which the fibers in said sheet have a low compaction separated by intermediate grooves in which the fibers in said sheet have a high compaction.

10. The sheet of claim 9 in which said grooves are compressed by a depth by about 16 to 25% of the caliper thickness of the sheet.

11. The sheet of claim 9 in which said grooves are substantially uniformly spaced from each other with a density of about 8 per inch.

12. The sheet of claim 6 in which each of the face surfaces of said sheet are formed with said ridges and grooves.

ABSTRACT

A wet felt for the press section of a paper pulp producing machine is formed with an array of machine direction extending heavy marking yarns on the face surface of the felt for the purpose of forming ridges and valleys in one or more of the surfaces of the sheet of pulp material before the sheet is delivered to an air dryer, for enhancing the drying rate and increasing the wet strength of the pulp sheet. A process is disclosed by which pulp sheets are formed with a grooved surface by pressing in the press section with a felt having machine direction cords formed in the felt to make such impressions, and the product so made in the process.

FIG. 1

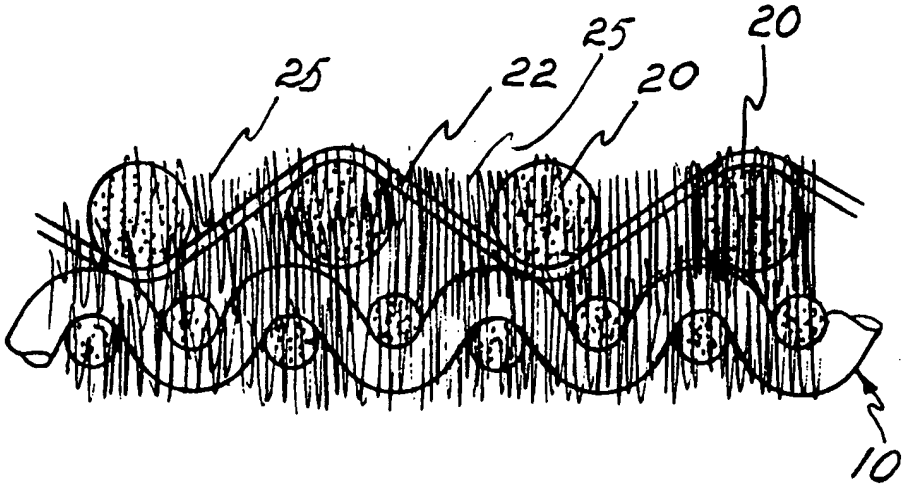
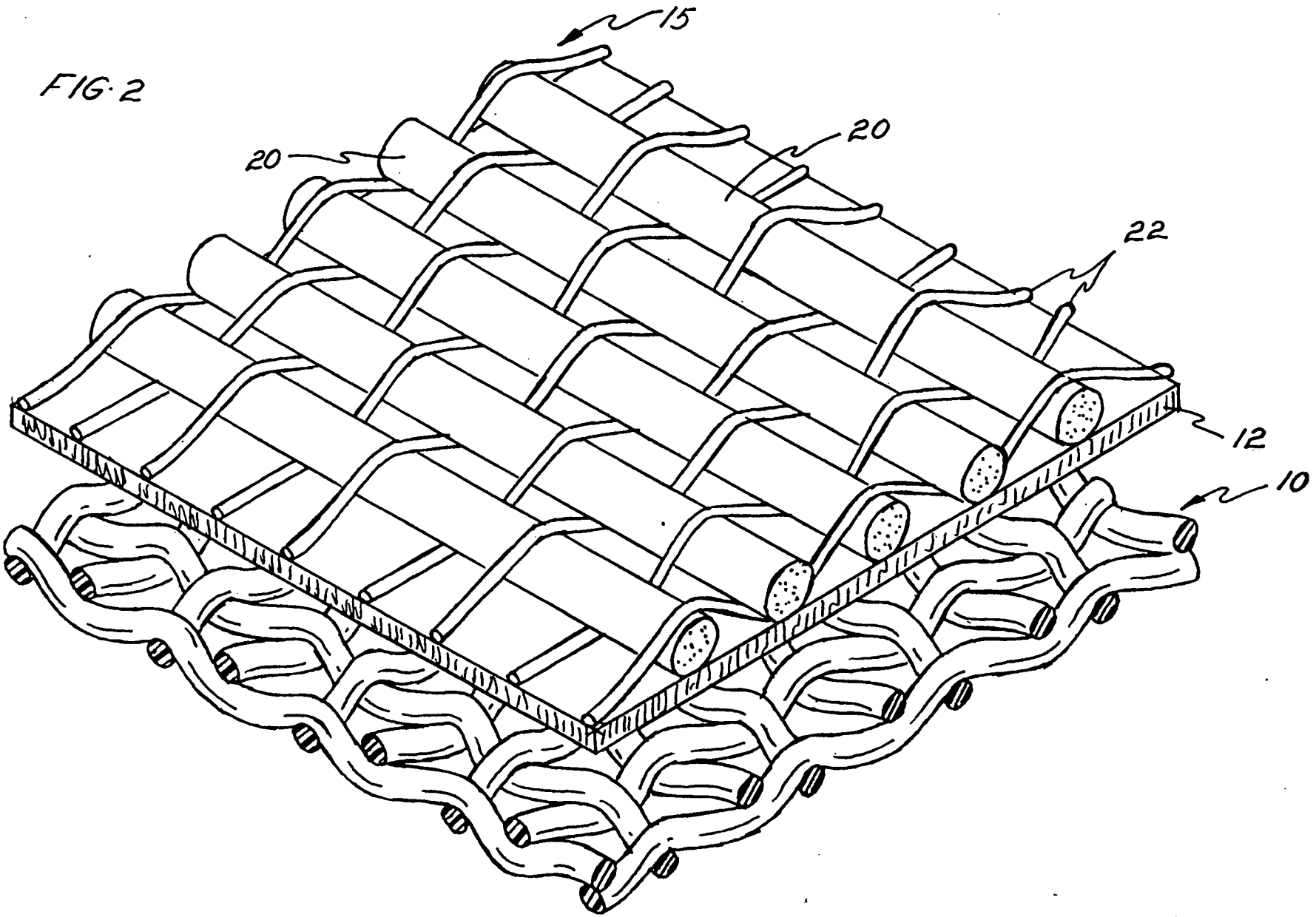


FIG. 2



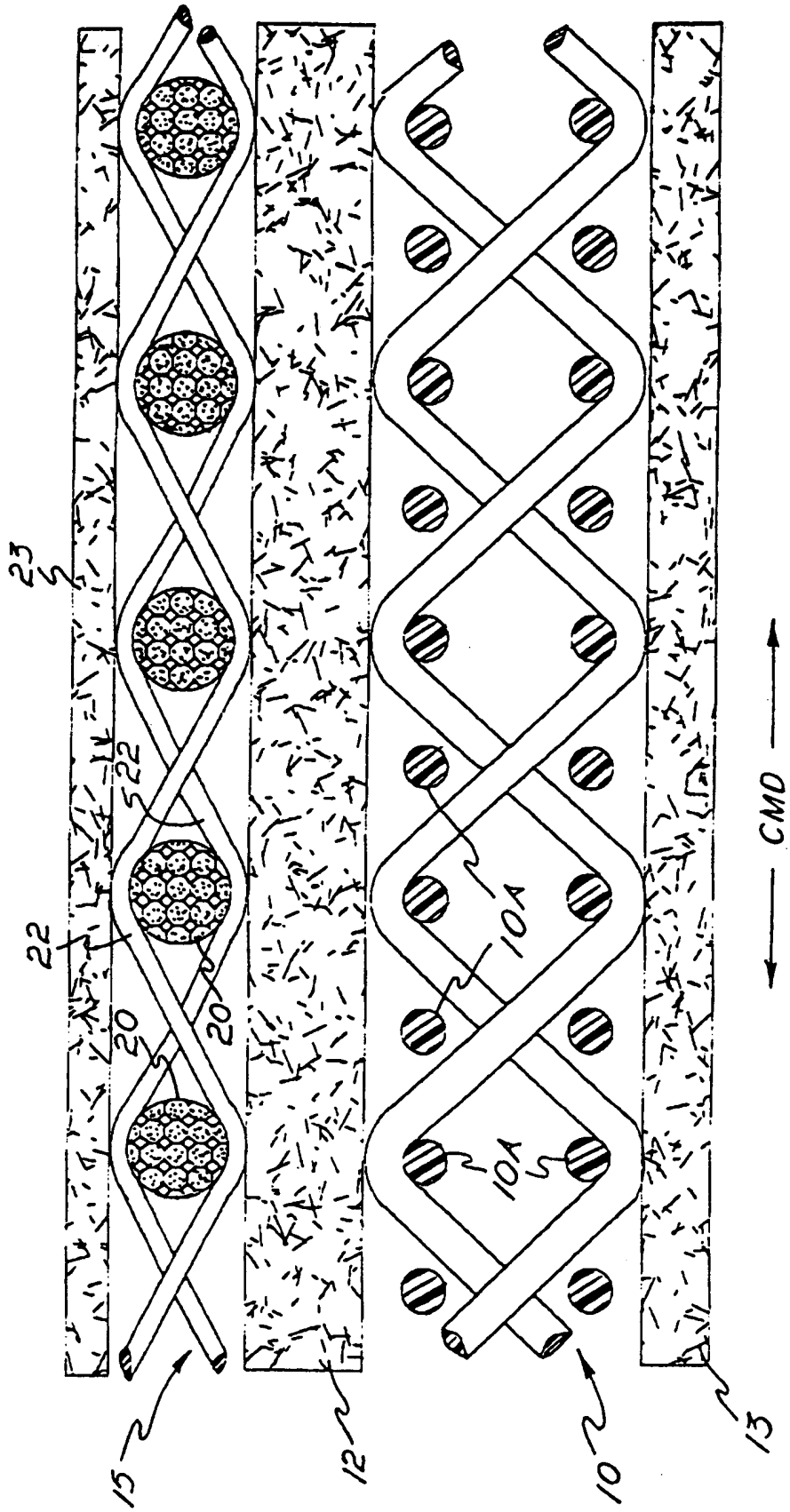


FIG-3

FIG-4

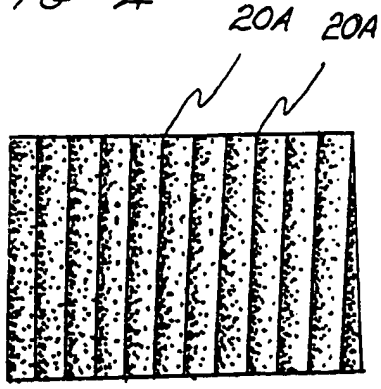


FIG-5

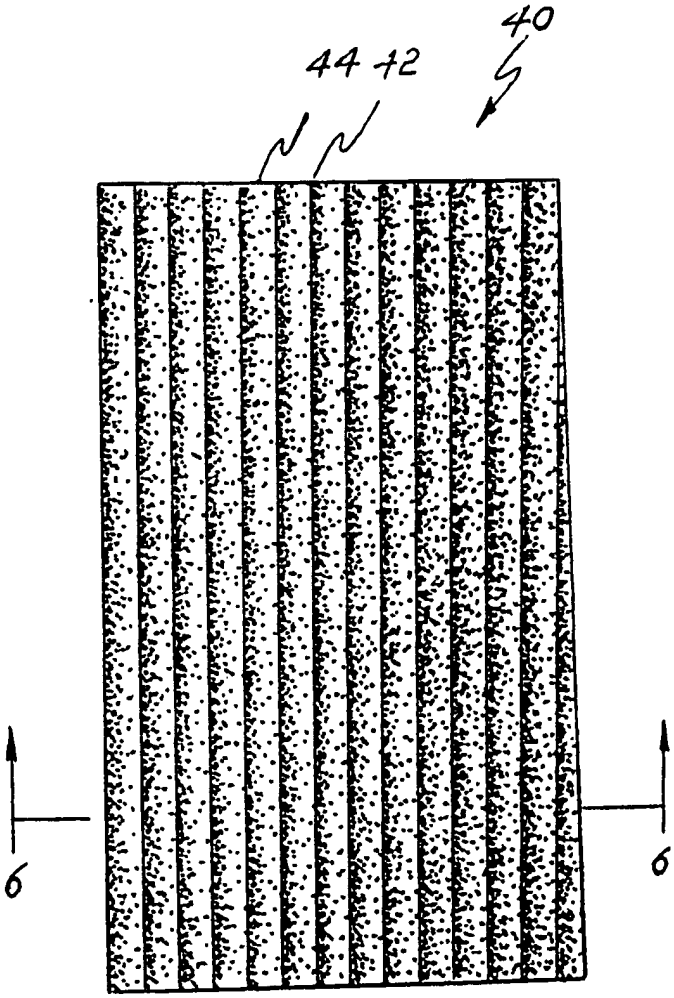


FIG-6

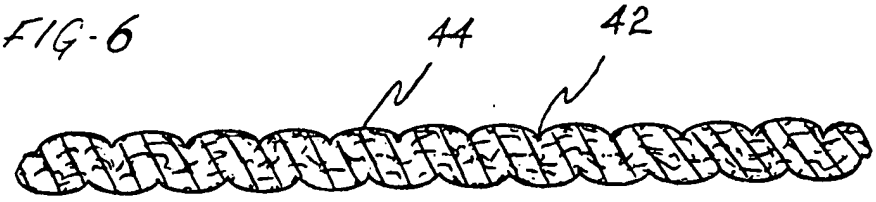
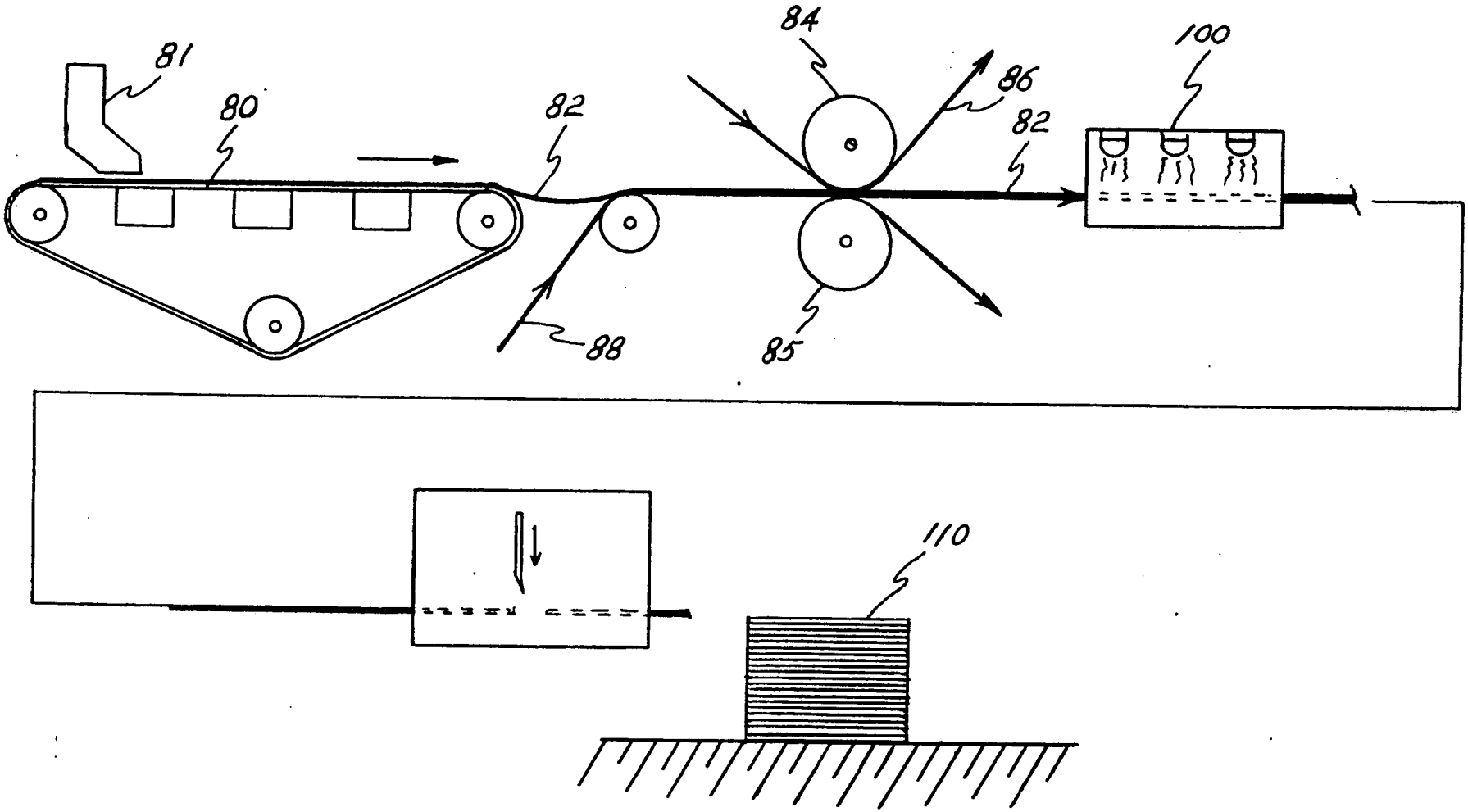


FIG-7



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